Preprint
UCRL-JC-150511

Dating Studies of Elephant Tusks Using Accelerator Mass Spectrometry

E. Sideras-Haddad, T. A. Brown

This article was submitted to
9th International Conference on Accelerator Mass Spectrometry,
Nagoya, Japan, September 9-13, 2002

October 3, 2002

U.S. Department of Energy

Lawrence
Livermore
National
Laboratory

This work was performed under the auspices of the United States Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

Dating Studies of Elephant Tusks Using Accelerator Mass Spectrometry

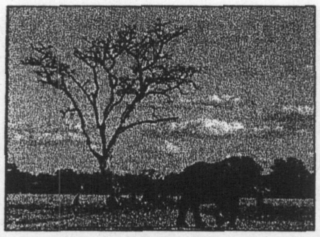
E. Sideras-Haddad[1] and T.A. Brown[2]

[1] *Schonland Research Centre for Nuclear Sciences, University of the Witwatersrand, Wits 2050, Private Bag 3, Johannesburg, South Africa,*

[2] *CAMS (Center for Accelerator Mass Spectrometry), Lawrence Livermore National Laboratory, Livermore, CA 94550, USA*

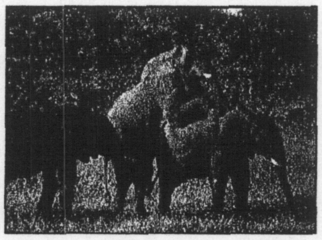
Abstract: A new method for determining the year of birth, the year of death, and hence, the age at death, of post-bomb and recently deceased elephants has been developed. The technique is based on Accelerator Mass Spectrometry radiocarbon analyses of small-sized samples extracted from along the length of the age-line of an elephant tusk. The measured radiocarbon concentrations in the samples from a tusk can be compared to the ^{14}C atmospheric bomb-pulse curve to derive the growth years of the initial and final samples from the tusk. Initial data from the application of this method to two tusks will be presented. Potentially, the method may play a significant role in wildlife management practices of African national parks. Additionally, the method may contribute to the underpinnings of efforts to define new international trade regulations, which could, in effect, decrease poaching and the killing of very young animals.

The African Elephant population has declined significantly during the last 25 years. African Elephants numbered approximately 1.3 million in 1978, while today there are only about 650,000 remaining in the wild. Loss of and fragmentation of natural habitat in Africa, together with poaching, are critical factors in causing this decline. The population decline seriously threatens the survival of the species.



Because of the decline, the African Elephant has been listed as a threatened species under the Endangered Species Act and African Elephants are now protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This protection makes trade in elephant products, including ivory, illegal.

However, within African National Parks uncontrolled increases in elephant populations.



. pose significant problems to wildlife management and the wild bio-diversity conservation programs of the Parks.

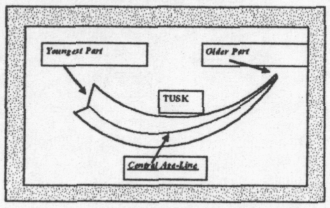
It has been shown that elephant populations larger than a critical level can have harmful effects on the well-being of a National Park. The National Parks are rather small natural ecosystems by comparison to the vast unspoiled areas of a century ago. In many instances natural migration patterns have been completely blocked, and the elephants diet and habitat usage patterns have changed. This can force serious changes in vegetation; in many cases throughout the African continent, woodlands have been replaced by grasslands.

In certain Southern African countries, elephant populations are no longer decreasing because of sound wildlife management practices.

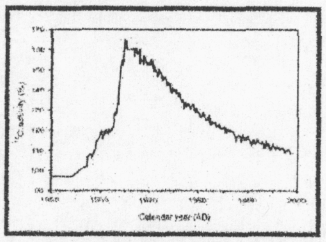
These habitat changes pose serious threats to the survival of a large number of species within such areas. In the case of the National Parks these elephant-population-related changes are clearly detrimental to the rich bio-diversity within the Parks. As a consequence, the elephant populations are regulated, through culling of the herds, to be within a critical range established for each particular National Park.

From a financial point of view, the upkeep of large wild reserves, such as National Parks, is a very expensive undertaking, particularly for some developing African countries. The revenue that could be derived from ivory sales of culled elephants in the National Parks could contribute significantly to the support that is needed for the overall conservation programs and the enormous upkeep expenses of these Parks.

In this study, we use ^{14}C measurements to extract time related information on distinctive characteristics of the tusk which are significant to wildlife forensics and the possibility of controlled trading. The information of interest in this study is age of the elephant at death and the time that has elapsed since death. The tusk samples for this study were taken along an *age-line* from each tusk; this sampling line presumably corresponds to the central longitudinal growth-line along the tusk from tip to root as shown in the figure below. There is a direct correspondence between tusk growth and elephant age; therefore, each sample along the growth axis of the tusk is representative of a specific period of the elephants growth. The difference between the dates assigned to the tip of the tusk and root of the tusk provides an estimate of the age of the animal at death. The time elapsed since the death of the elephant is indicated by the date assigned to the root, which is the youngest part of the tusk.

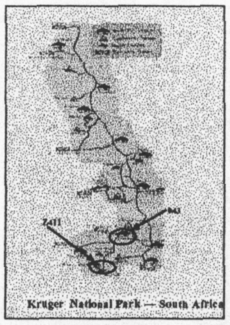


In this study, we have assigned growth years to particular tusk samples dates through comparison of the measured radiocarbon concentrations of the tusk samples to the atmospheric ^{14}C bomb-pulse caused by atmospheric nuclear weapons tests in the 1950s and early 1960s. Because of the double valued form of the atmospheric ^{14}C concentration anomaly, we have measured a series of samples from along the age-line in the middle of the tusk to ensure that we could avoid confusion as to the correspondence of our results to particular portions of the ^{14}C bomb-pulse. The ^{14}C-dating was accomplished using accelerator-based mass spectrometry (AMS), which is ideally suited for these dating studies because of the small-size samples that can be used.

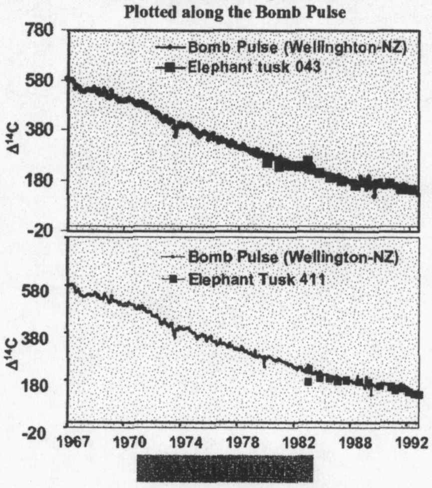


^{14}C activity for the South hemisphere over the period 1950 to 2000 (J.C. Vogel *et.al*, QUADRU CSIR, South Africa.)

Tusks from two elephants that lived in different regions of the Kruger National Park in South Africa were offered by its Scientific Services Department. One of the tusks was about 70cm long and the other about 100 cm. The locales within which the elephants were known to have lived are indicated below.



$\Delta^{14}C$ Values from Elephant Tusks Plotted along the Bomb Pulse



In this study we have obtained initial data showing that ^{14}C AMS measurements on samples from elephant tusks can be used to estimate the year of birth, the year of death, and hence, the age at death, of post-bomb and recently deceased elephants.

The availability of such estimates may prove useful in attempts to define additional international trade regulations. Such regulations might utilize the age information to restrict tusks traded in the international market to those that have been kept in storage for, say, greater than ~25 years, with determined ages of death predating ~1975. Additionally, the regulations might require that traded tusks must originate from elephants whose age at death was greater than 25 years in order to ensure at least one mating and to protect the younger animals. Potentially, such regulations would impose tremendous difficulties to poachers/traders who would have to store illegal tusks for long periods of time.

This work was performed, in part, under the auspices of the US Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.